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NIGHT VISION TRAINING IN THE ARMY AIR FORCES

DETLEV W. BRONK
Coordinator of Research
Office of The Air Surgeon
Headquarters, Army Air Forces

The physiological ability to see well in daylight has been one of the most exacting physical standards set by the Flight Surgeon. The capacity for seeing at night, on the other hand, has received no more than perfunctory consideration. There have been two principal reasons for this. It is due, in part, to the fact that most physicians and physiologists are not as well informed of the phenomena concerning night vision as they are of the mechanism of day vision. Furthermore, until recent years, there has been little need or opportunity to use only rod vision in Air Force operations.

In 1940, a group of physiologists including Selig Hecht, Walter Miles, Keffer Hartline and the author, with the assistance of the National Research Council, sponsored a series of field surveys of night vision among service personnel. The late Commander Eric Liljencrantz conducted a study aboard the aircraft carrier "Enterprise." Dr. P. Robb McDonald measured the night vision of about 1,000 cadets at Randolph Field, and Dr. James C. Peskin tested a similar number at Fort Bragg. Their findings were essentially in agreement with Hecht's previous laboratory studies on civilian personnel and showed that, among a normal population, some individuals are fifteen times better fitted by their retinal characteristics for night observation than are the poorest, and five to ten times better than the average. This suggested the possibility of selecting individuals who are naturally qualified for exacting night duty, and of eliminating the unfit.

The results of these surveys and the extensive testing program of the Royal Air Force stimulated a desire to incorporate some test for night visual capacity in the AAF battery of physical examinations. But practical difficulties in the accomplishment of this objective soon became apparent. Careful laboratory measurements of rod thresholds, made with precise instruments are meaningful. To make such tests on the vast flow of flying personnel in the AAF would have required instruments, trained operators and testing time that were not then available. On the other hand, careless measurements with crude instruments give no significant measure of a man's retinal characteristics and, therefore, cannot be fairly used as a basis of selection. There were, however, many who tried to find the means with which to short-cut the requirements of precise measurement. "Adaptometers" for the testing of night vision individually or by groups, cheaply made or precisely constructed, giving a measure of rod function or of no function at all began to blossom or, in many less enlightened cases, to mushroom in laboratories throughout the country. The situation became thoroughly confused. After all this furor of amateurs and the restraint of experts, a satisfactory field test of night vision is still made only with great care.

The growing concern for night vision had more fortunate and immediately practical side-effects. Thus, red goggles were developed for preserving dark adaptation prior to night operations. Cockpit and instrument panel lighting were redesigned, especially in Navy and RAF planes, so as to interfere as little as possible with rod vision. The harmful effects of searchlights and the necessity for good visibility through transparent enclosures were emphasized.

Throughout the struggle to devise a satisfactory test for night vision General Grant kept insisting, with characteristic discrimination, that training in the use of the eyes at night would probably prove more useful than selection of the best, or elimination of the poorest individuals. This led us to include in the course for aviation physiologists at the AAF School of Aviation Medicine lectures on night vision, and some brief instruction relating to the use of the eyes at night was prescribed in the syllabus for the Altitude Training Program. It was typical of the initiative of the aviation physiologists that many of them developed more extensive programs of night vision training in order to meet the special needs of their students. Only a continuing conviction in some quarters that training and combat operations would not, and could not, be carried out under conditions of illumination requiring rod vision prevented us from granting more time and facilities for such work.

During a mission to the ETO in the summer and autumn of 1943, I had many opportunities to see, with the sole aid of rod vision, the character of RAF night operations. This, and the excellent accomplishments of the RAF night vision training program, persuaded me that we should be negligent in our preparation for future changes in AAF strategy and tactics if we did not insist on more adequate instruction and training in night vision. Fortunately, my return to Headquarters coincided with a request from Major General Harper, AC/AS, Training, to The Air Surgeon, for advice regarding the desirability of more training along these lines.

Accordingly, plans for a night vision training program were formulated, with the assistance of the Subcommittee on Visual Problems of the National Research Council. Also precedents were available in the RAF program and in those of the USN Submarine Base at New London and of the RCAF at Montreal. From the latter, and especially from its director, Wing Commander Evelyn, much useful advice was secured. Following their experience, a training device for the projection of stationary and moving objects onto a dimly illuminated screen was constructed by Dr. Lorus Milne and Dr. Keffer Hartline of the Johnson Research Foundation, working under a contract with the Committee on Medical Research of the Office of Scientific Research and Development. To Dr. Lorus Milne, who has supervised the design and construction of the trainers, goes much credit for imagination and persistence in overcoming many difficulties.

It was our belief that this training was a proper function of the aviation physiologists and a natural extension of the activities of the altitude training units. Accordingly, the first projection trainer was installed at the Columbia Army Air Base Altitude Training Unit. It was used as the central feature of a one and one-half hour lecture-demonstration. This experimental program was begun in the late winter of 1944 and immediately received the enthusiastic indorsement of the flying personnel passing through the replacement training pool at Columbia. About that time, there was a growing demand for such training from various

operational and training establishments. This was especially true of the I Troop Carrier Command, and my observation of an airborne divisional maneuver at Camp Mackall, carried out largely by night, further convinced me of the necessity for pushing forward with this type of training activity. The subsequent, widespread acceptance of this program throughout the Air Forces is due in no small measure to the enthusiastic demonstrations of Lt. Charles Wilson at many stations.

From the experiences in the training of thousands of aircrew men at Columbia the present program and training devices have evolved. Nine night vision trainers have been constructed by the Johnson Research Foundation and have been located in various stations in this country and in the MTO. Fifty additional trainers are being manufactured through the agency of the Training Aids Division. Unfortunately, the delay of nearly a year in their construction is a discouraging record of inefficiency and lack of proper respect for the human factors necessary for safe and efficient military operations.

The training device is a cubic box about 3 feet on a side, with one side open. An ophthalmoscope bulb provides a point source of light operated on a stabilized power supply, controlled for intensity through a rheostat. It is thus possible to illuminate at various brightnesses a screen, 8 feet by 12 feet in size, at the end of the demonstration room. A motor-driven disc mounted from the top of the box, carries suspended models of aircraft which move through the beam of light. Because the disc can be tilted or reversed in direction of movement, the silhouettes appear in unanticipated areas of the screen. At the lower front of the box there is a movable roller on which there are mounted three sets of cardboard cut-outs of objects such as hangars, grounded aircraft, control towers, trees, hills, etc., which give a realistic horizon on the screen. A lower, motor-driven disc carries cardboard cut-outs of jeeps, troops, tanks, etc., which pass through the light beam, so their shadows move across the screen. Observations are usually made at the brightness levels corresponding to a starlit sky, but certain features of the lecture may be illustrated by increasing or decreasing the brightness, or by flooding the screen with a diffuse light from a second source, thus simulating the effect of ground haze. A battery of high intensity floodlights on either side of the screen are used to destroy dark adaptation in the manner of a searchlight beam. A kodaslide projector, mounted on the top of the trainer box, is available for projecting faintly illuminated images of target areas, as they would be seen from the air at night.

By using this training device it is possible to give in 90 minutes a lecture demonstration in which the student discovers for himself the fundamental facts of night vision, hearing an explanation of the phenomena as they are revealed. This combination of demonstration and exposition is a dramatic experience when properly conducted; it fixes the few basic principles of night vision so that they will not be soon forgotten, and it emphasizes the need for continuing practice in the development of proper habits of seeing at night. During the course of such a demonstration there are frequent opportunities for describing operational practices and instrumental devices, suggested by the visual characteristics under discussion.

The objectives of this training program and the military organization under which it will be carried out are described in AAF Letter 50-18, issued under date of 9 April 1945. The general purposes, which are enumerated in that letter, are directed to the improvement of seeing at night. To accomplish this, students are told some of the elementary facts about the eye and visual mechanisms, in order that they may know why certain practices and precautions are necessary. The technique of scanning and off center vision are demonstrated, and actual practice of night visual procedures is encouraged. Means for the protection of dark adaptation, various visual aids for night operations, such as charts, improved lighting systems, clean transparent inclosures, and night glasses are described. All of this instruction is based on a visual demonstration of each fact and principle as it is presented.

Those who can benefit most from this instruction are the trainees and redeployed personnel who will soon go into combat. Accordingly, the first trainers that became available were sent to "very-heavy" and "heavy" bomber CCTSs. They were also sent to the Lincoln Army Air Base for the instruction of fighter pilots and medium-bombardment crews. In this way we are teaching as many officers and men as possible before they enter combat.

Similar instruction will be given to all flying personnel in the basic schools and in the flexible gunnery schools of the Training Command. At first, it was our purpose to begin instruction in the specialized schools, but a recent report issued by the Office of Flying Safety on "Night Flying Accidents," July-November 1944, reveals the fact that there are 1.5 to 5.4 times as many training accidents in night flying as in day flying, depending on the type of aircraft; 2.3 times as many fatal accidents. These statistics emphasize the necessity for preparing the student personnel in every way possible for night operations from the time they begin their night flying training. We believe that this program of instruction will be an important factor in reducing the number of casualties.

The trainees who have received this instruction in night vision in the gunnery and basic schools will, of course, not require similar training at Lincoln or in the CCTSs. Accordingly the teaching at those stations will be changed when previously trained students begin to arrive. There will then be an opportunity to use night visual training devices for further practice in the development of proper visual habits. This will include the use of photoelectric target guns; target spotting on dimly illuminated pursuit meters; and other devices which will arouse the interest and develop the night-seeing abilities of the trainees. It is our hope that here it will also be possible to give instructions and advice relating to instruments and navigation aids which facilitate night operations.

The conduct of this program is a natural function of the Aviation Physiologists. However, despite their familiarity with the human problems in military aviation and their broad scientific training, many of them lacked an extensive knowledge of the physiology and optics of vision. Recognizing that a teacher should possess understanding that far outreaches the limits of the subject matter he must teach, we have instituted three courses in visual physiology. These courses were made possible by the cooperation of the Committee on Medical Research of the OSRD, the Division of Medical Sciences of the NRC and the Johnson Research Foundation of the

University of Pennsylvania. Here is the typical program of lectures and demonstrations, omitting the unscheduled, but equally stimulating, evening activities:

MONDAY	
Introduction - Dr. Detlev Bronk Status and Regulations Concerning Night Visual Training in the Army Air Forces	1030
The Physiology of Vision - Dr. Selig Hecht - Columbia University Histology of the Retina Photochemistry of the Visual Mechanism Dark Adaptation Spectral Sensitivity of the Retina, etc.	1130
Lunch	1200
The Physiology of Vision - Dr. Selig Hecht	1300
TUESDAY	
Physiology of the Pupil - Dr. Irving Wagman	0900
The Effects of Oxygen Lack on Vision - Dr. Selig Hecht	1030
Lunch	1200
Demonstration of Visual Tests for Anoxia in Chamber "Flights"	1300
WEDNESDAY	
Suggested Lecture-Demonstration - Lt. Charles C. Wilson	0900
The Night Vision Projection Trainer - Dr. Lorus J. Milne	1100
Lunch	1200
Administrative Problems Relating to the Night Vision Training Program - Lt. Charles C. Wilson	1300
Aircraft Recognition Program in the AAF - Major Davidson	1400
THURSDAY	
Psychological Problems Concerning Vision - Dr. Walter Miles - Yale University Advice on Training Methods Perceptual Problems Visual Clues in Night Operations Autokinetic Phenomena	0900
Lunch	1200
Psychological Problems Concerning Vision - Dr. Walter Miles	1300
Visual Tests and Standards in the AAF Major P. Robb McDonald	1500

FRIDAY

Photometry at Low Brightness Levels Dr. Keffer Hartline	0900
Visible Ranges of Objects at Night - Dr. Keffer Hartline	1000
Dazzle and Glare - Dr. Keffer Hartline	1100
Lunch	1200
Aircraft Lighting and Optical Properties of Aircraft Inclosures - Dr. Keffer Hartline	1300
Demonstration of Navy Instrument Lighting Project Franklin Institute - Lt. John Bromer	1600

SATURDAY

Goggles - Dr. Glenn Millikan	0900
Night Glasses and Binocular Characteristics Dr. Keffer Hartline	1000
Conference, Discussion, and Summary	1100

About fifty Aviation Physiologists were thus trained in these courses at the Johnson Research Foundation. Selection for assignment was made on the basis of known previous interest in visual problems, availability for employment in this program, and the usual relevant and irrelevant considerations that determine personnel assignments. At least one further course is planned for some undetermined future date.

The primary function of the Night Vision Training Program is to increase the efficiency of AAF flying personnel and to protect their safety. The accomplishment of these objectives should certainly follow a better understanding of the nature of night vision, the means for its protection and the proper procedure for seeing at night.

A secondary consequence will be a further increase in the scope of the Aviation Physiologists' activities. Only three years ago, in July 1942, the first certified Aviation Physiologist in the history of the Air Forces was graduated at the School of Aviation Medicine for duty in the Altitude Training Program. We had confidence, however, that there were wider fields of usefulness for officers with physiological training. In order that they might be ready to meet that greater challenge we commissioned only men with a broad scientific training and gave them the additional advantage of instruction at the School of Aviation Medicine. As the physiologists have learned the problems of military aviation, they have steadily increased their range of usefulness. In three years they have established physiology as a science which is necessary to the operation of the Army Air Forces. I know of no chart for the future which omits Aviation Physiologists from the category of essential personnel. The time has now come when the Altitude Training Program could more appropriately be designated the Aviation Physiology Program, in recognition of the many and diverse contributions of our Aviation Physiologists.

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PROPHYLAXIS AGAINST AERO-OTITIS MEDIA: AN INDOCTRINATIONAL FUNCTION OF THE ALTITUDE TRAINING PROGRAM

PAUL A. CAMPBELL
Colonel, Medical Corps
AAF School of Aviation Medicine
Randolph Field, Texas

As aero-otitis media ranks first among the occupational diseases associated with aviation, its prevention proposes a challenge to all agencies and individuals charged with the physical well-being of airmen.

It is quite generally agreed by those individuals who have had most experience with operational aero-otitis media that the most important single contribution directed toward lowering the incidence of ear barotrauma and the consequent military loss lies within the province of indoctrination, and thus primarily within the realm of the altitude training program.

To be sure, the basic physics of the effect of barometric pressure change upon the ear and the basic physiology of ear ventilation have been well taught to Army Air Forces personnel during their indoctrinational flights. However, it is plausible that the high incidence of aero-otitis media for operational air forces may be reduced if even more intensive training in measures for protection of the ear are instituted. This opinion has been expressed by Flight Surgeons, Aviation Physiologists, ear-nose-throat consultants, and others in the European Theater of Operations.

The problem of aero-otitis media is very real. This is especially true in the strategic air forces during the winter months. In one air force on one occasion twelve per cent of those personnel who were grounded for physical reasons were grounded for aero-otitis media.

Toward increasing the emphasis on ear protection in the altitude training program it is believed worthwhile to reiterate a few facts. It is well known that the incidence of aero-otitis media is inversely related to air experience, as in most instances an airman learns better how to ventilate and consequently to protect his ears as his hours of flight are accumulated. There are, of course, exceptions known to all of us, but if there is something most airmen can learn to do to protect themselves they should by all means be taught these protective procedures in a well-regulated and supervised medium such as the altitude training program.

A few of the procedures which the airman learns with experience are to remain alert for descent, and during descent to voluntarily swallow more frequently, regulating the time interval between the acts of swallowing in relation to the speed of descent. He learns not to recline during descent. He quickly learns to recognize intractable eustachian tube blockage and to reascend when it occurs. He learns to perform various auto-inflation maneuvers to force middle ear ventilation. He also learns not to fly while experiencing an episode of nasopharyngitis or, if flying is absolutely necessary, to take certain precautions such as reporting to his Flight Surgeon for nasal shrinking medication and other care. These protective measures which the experienced aviator has learned should by all means be made a

part of his training. This training should be instituted in the earliest possible portion of his flying career. The altitude training chamber offers an excellent opportunity for impressive indoctrination in this regard.

It is probably worthwhile in this connection to point out some of the facts and fantasies regarding auto-inflation procedures. The dangers of auto-inflation in the presence of nasopharyngitis has long been a matter of controversy. Many clinicians have pointed out that the maneuver might force infected materials into the middle ear, thus favoring the production of purulent aero-otitis media. Theoretically, this may be true. However, such an occurrence is extremely rare unless the mucosa of the middle ear is already traumatized. It is the opinion of most observers experienced in the care of flying personnel that the dangers of descent with a blocked eustachian tube far outweigh the dangers of infecting the middle ear by auto-inflation.

It might also be emphasized here that each experienced flyer has his own method of preference relative to ventilation procedures. This disparity of choice of auto-inflation maneuvers points to the fact that due to anatomical and physiological differences, each produces varying degrees of success in different individuals. Thus all of the methods should be demonstrated and practiced and the individual allowed to select that which is most successful in his particular case.

The maneuvers most efficient for middle ear ventilation are:

<u>The Valsalva maneuver during the act of swallowing</u>. This is performed by gently pressing the alae of the nose together, and attempting to expire forcibly against closed lips, while swallowing simultaneously. In the experience of the author this method of auto-inflation is effective for more individuals than any other.

<u>The Valsalva maneuver without swallowing</u>. This method is effective in many people.

<u>Forced voluntary swallowing</u> while pressing the base of the tongue upward and backward into the posterior pharynx.

<u>Voluntary yawning</u> with the jaw thrust forward. This procedure has been described as a stifled yawn. Some airmen move the jaw from side to side while voluntarily attempting to yawn.

<u>Moving the lower jaw</u> from side to side and forward and backward while moving the external ear up and down manually. The benefits derived from such movements of the external ear are doubted by many investigators, but others are just as emphatic in their claim that it is an effective maneuver.

It should also be pointed out that bending the neck laterally to stretch the neck muscles on the affected side while at the same time stretching the chin upward and forward will increase the ability to ventilate the middle ear in many individuals.

It would be remiss to conclude without calling attention to the fact that the altitude training program also has an important function relative to the screening out of those individuals who have intractable eustachian tube obstruction. In each instance coming to the attention of the Aviation Physiologist the Flight Surgeon should be informed. The Flight Surgeon and the Aviation Physiologist, acting as a team, can do much to decrease the number of flying personnel who may later be eliminated due to the development of chronic aero-otitis media.

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THE INFLUENCE OF CHEST DEFORMITIES ON THE INCIDENCE OF ADVERSE REACTIONS TO SIMULATED HIGH ALTITUDES

CAPTAIN OSCAR D. RATNOFF, M. C.
Altitude Training Unit
San Antonio Aviation Cadet Center

A small percentage of air crew candidates have deformities of the bones of the chest. A study has been made to determine whether the presence of these deformities affects the tolerance of these individuals to high altitudes.

Thirty-one air crew candidates with chest deformities were given a simulated flight in the low pressure chamber. A review of their Type 64 physical examinations showed that although each of these subjects had a depressed sternum of sufficient degree to warrant investigation, none gave any history of cardio-vascular difficulties prior to the examination. Routine X-ray examination of the chest revealed no abnormalities except in one individual. In this subject the transverse diameter of the cardiac shadow was 10 percent greater than the predicted normal. Fluoroscopic examination of the chest was made in 27 of the 31 subjects. Twelve of these showed displacement of the cardiac shadow by the depressed sternum, and in 6 of these 12 the cardiac shadow impinged upon the posterior mediastinum. In no case was any obstruction of mediastinal structures observed. The vital capacity of twelve of the subjects was measured, and in all but two was within normal limits. The vital capacity of one of these subjects, accepted for air crew training, was 2900 cc; and of the other, grounded, was 2450 cc. Of the 31 candidates, 25 were physically acceptable for air crew training, and 6 were rejected. Those grounded were all eliminated at least in part because of substandard Adaptability Rating for Military Aeronautics, and only one because of the presence of chest deformity.

The thirty-one subjects were given a "Type I" flight in the low pressure chamber. In this flight, the subject is taken to a simulated altitude of 18,000 feet and remains at that altitude for 6 minutes without supplementary oxygen. Then, using a continuous flow oxygen mask, he ascends to 28,000 feet, and finally descends to ground level. Under these conditions, 6 percent of normal subjects have symptoms of anoxia, and adverse reactions requiring an emergency descent to ground level occur in 0.1 percent of subjects.

In none of the 31 subjects with chest deformities was there any adverse reaction to a simulated flight to 28,000 feet. In this group of air crew candidates, therefore, the presence of chest deformities did not increase the rate of adverse reactions to simulated high altitudes.

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EDITOR'S NOTE:

The following information regarding oxygen manifold regulators has been received from the Air Technical Service Command:

> Replacement oxygen manifold regulators for all types of Altitude Training Chambers are available in Army Air Force stock, Class 05-B. Bastian-Blessing replacement right and left hand mounting regulators are Stock No. 7800-686025 and 7800-686000 respectively. Linde regulators are listed under Stock No. 7800-687025 for right hand mounting and Stock No. 687000 for left hand mounting. Replacement regulators should be requisitioned through channels and if an emergency need arises, the request should be made by priority message to Headquarters Air Technical Service Command, Attention Unit TSSEQ10B.
>
> Upon receipt of the replacement regulator, the defective one should be tagged repairable and forwarded immediately to Fairfield Air Technical Service Command, marked, Attention, Class 05-B Supply Supervisor.
>
> Regulators will be rebuilt by the manufacturer and returned to stock for re-issue.

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NOMOGRAPHS FOR ESTIMATING OXYGEN DURATION AND OXYGEN SYSTEM LEAKAGE

CAPTAIN ASHER E. TREAT, A. C.
Altitude Training
San Antonio Aviation Cadet Center

Oxygen duration chart. The duration of an oxygen supply cannot be predicted from a single pressure reading unless the volume of the supply is also known. In combat aircraft, one or more oxygen cylinders may be punctured without any immediate effect upon the gage pressure. For this reason, after the airplane has been under fire, the volume of the oxygen supply often cannot be known with certainty. To estimate the oxygen duration at a given rate of loss, it is therefore necessary to divide the available pressure by the rate of pressure change, as indicated by successive gage readings. The accompanying nomograph (Figure 1) provides a simple and rapid way of making this estimate.

The scales have been drawn on the basis of a total available pressure range of 400 to 50 p.s.i. Since the rate of pressure loss will vary with the altitude, activity, and temperature, the measurements should be repeated at frequent intervals. It is suggested that in multiplace aircraft, this be done by the responsible crew member as a part of the regular oxygen check.

Oxygen system leak chart. The oxygen system leak test performed as a part of the 50-hour airplane maintenance inspection (T.O. No. 03-50-1) requires a determination of the pressure loss, corrected for temperature change, over a period of 12 hours. The accompanying nomograph (Figure 2) eliminates the calculations involved in this procedure.

TO ESTIMATE OXYGEN DURATION AT PRESENT RATE OF LOSS:

1. Read the pressure gage to the nearest 10 psi.
2. Wait 15 minutes.*
3. Read the gage again.
4. Subtract the second gage reading from the first. The difference is Δ P on scale B.
5. Lay a straightedge so that it intersects the second gage reading on scale A, and Δ P on scale B.
6. Read OXYGEN DURATION IN HOURS where the straightedge intersects scale C.

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* If readings are taken at intervals other than that of 15 minutes. multiply the observed pressure loss (i.e., the difference between the two readings) by 15/m , where m is the chosen interval in minutes. This gives Δ P. Then proceed as above.

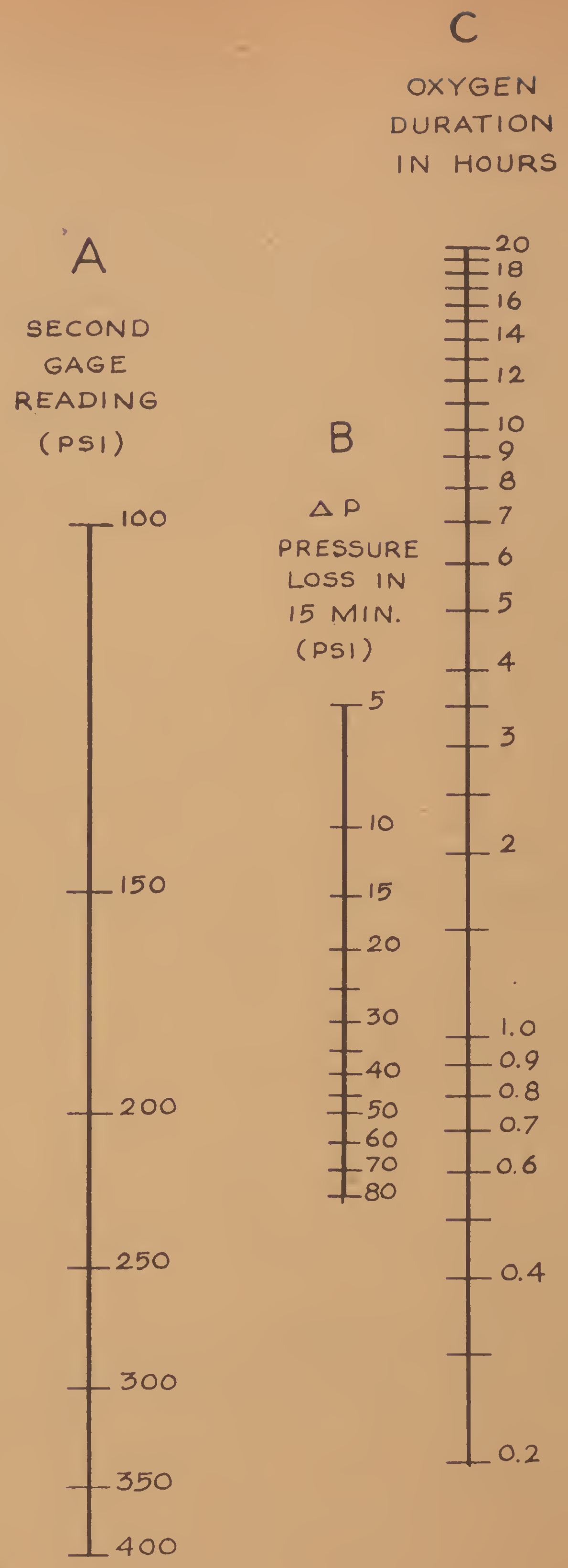

Figure 1. OXYGEN DURATION CHART

TO FIND THE AMOUNT OF LEAKAGE IN 12 HOURS:

1. Read and record the oxygen gage pressure.

2. Read and record the air temperature.

3. Wait 12 hours.*

4. Read gage pressure again, and subtract the second reading from the first to find the 12 HOUR LOSS OF PRESSURE on scale A.

5. Read the temperature again. Note whether it has gone up ( ) or down ( ) and how much. This gives the 12 HOUR CHANGE IN TEMP. on scale B.

6. Lay a straightedge so that it intersects the LOSS OF PRESSURE on scale A, and the CHANGE IN TEMP. on scale B.

7. Read the 12 HOUR LEAK on scale C.

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* If a shorter interval is used for the test, multiply the observed loss of pressure by 12/H , where H is the number of hours between readings. This gives the 12 HOUR LOSS OF PRESSURE on scale A. Then proceed as above.

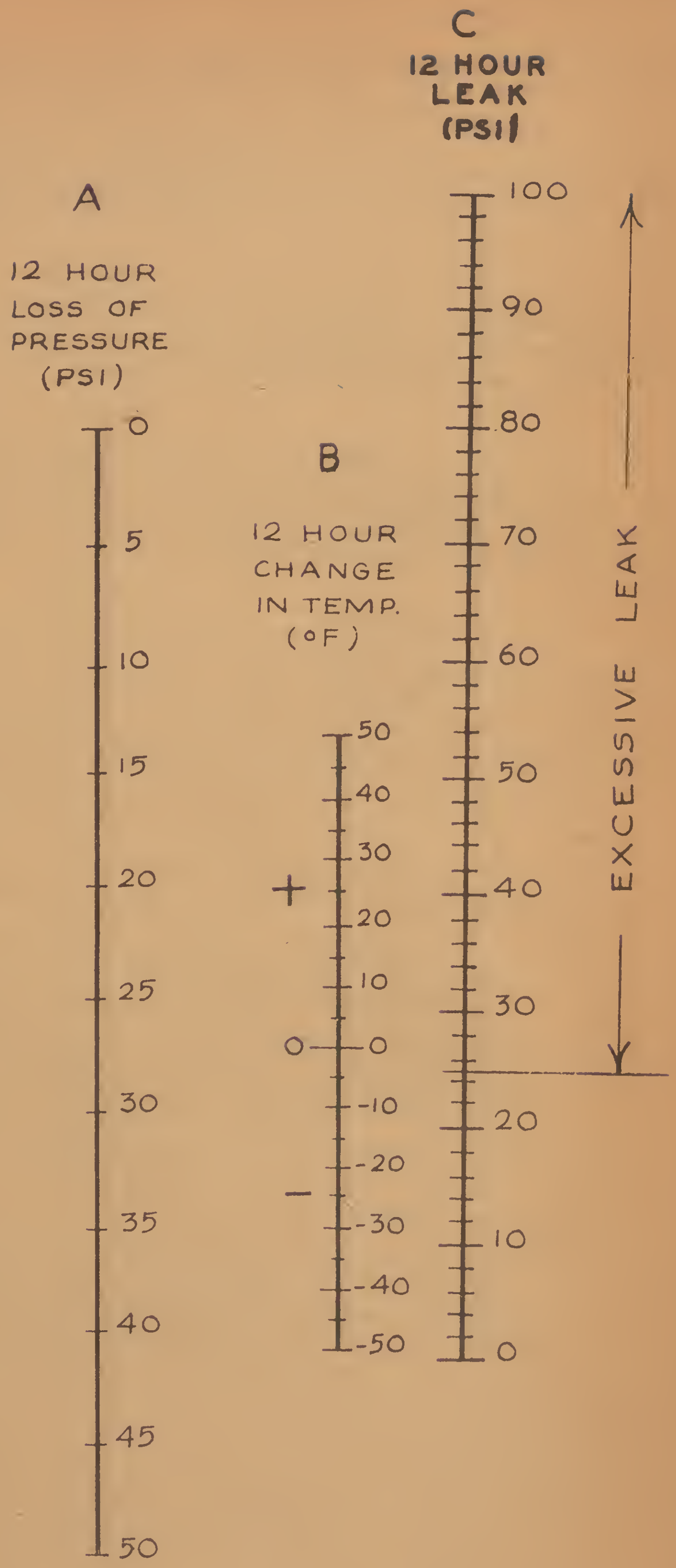

Figure 2. OXYGEN SYSTEM LEAK CHART

A STUDY OF THE MEDICAL RECORDS OF A SMALL GROUP OF TECHNICIANS WHO WERE RELIEVED OF ALTITUDE CHAMBER DUTIES FOR MEDICAL REASONS

CAPTAIN JOHN W. BRICKER, M. C.
Altitude Training Unit
San Antonio Aviation Cadet Center

PURPOSE

To determine the possible existance of a common denominator in the medical psychological changes occurring in a small group of altitude chamber technicians who were relieved of altitude chamber duties for medical reasons.

METHOD

A total of 40 interval types 64 examinations together with laboratory studies on a group of 17 altitude chamber technicians were reviewed with tabulation of the physical findings by system. Correlation was made between duration of exposure to simulated altitudes and cause for elimination from chamber duties.

DISCUSSION

The study revealed the most common cause for elimination from chamber duties to be "operational fatigue," seven cases; in the order of frequency other reasons were psychologically unfit, 2 cases; suppurative aerotitis, 1 case; electrocardiographic changes, 1 case; perforation of left tympanic membrane, 1 case; history of post appendicial adhesions, 1 case; positive Kahn, 1 case; and marked susceptibility to bends, 2 cases.

Further observations of this heterogeneous group reveals that it can be subdivided as follows:

1. Four cases were grounded on the original 64 examination without significant exposure to simulated altitudes.

    a. A 25 year old Pvt. disqualified because of lack of interest, had no unusual findings on his type 64 examination. Original elimination from Cadet training was made on the basis of excessive esophorias.

    b. A 22 year old Pfc. was disqualified by a history of a surgically drained appendicial abscess in 1934, followed by appendectomy in 4 months, and intestinal obstruction necessitating surgical intervention in 1942.

    c. An 18 year old Pvt. was disqualified by a history of chronic otitis media, 1930-1939, with perforation of the left tympanum, observed on his initial 64 examination.

    d. A 24 year old Pfc. was disqualified by the occurrence of aerotitis from the 5,000 foot ear check in the pressure chamber. There was a history of otitis media, suppurative, right, in February 1944 without sequelae. Examination of the right tympanum and audiometry were not remarkable.

2. Two cases were grounded after a variable period of exposure to simulated altitudes by reason of findings unrelated to chamber flights.

a. A 23 year old Cpl. was disqualified on his third 64 examination after 37 chamber hours by the appearance of a positive blood Kahn. Except for consistent failure to pass the color vision tests his examinations were negative.

b. A 25 year old Pvt. originally eliminated from Cadet training by air sickness, was disqualified after 49 chamber hours because of traumatic arthritis of the right knee with roentgenographic evidence of right tibial calcification. Three interval 64 examinations were negative. No details of symptomotology were given.

3. Four cases were grounded after a variable period of exposure to simulated altitudes by reason of findings apparently related to chamber flights.

a. A 20 year old Pvt. was eliminated from chamber duties after 30 chamber hours as psychologically unfit. His past history was negative and his 64 examination was normal. No further comment was made.

b. A 24 year old Pvt. was eliminated after 110 chamber hours by an increasing frequency of aeroembolism with persistent fatigue of several days duration after each attack. He became increasingly apprehensive about possible permanent ill effects. A comparison of three interval 64 examinations with laboratory studies revealed all to be normal except for consistent failure to pass the A.O.C. color plates.

c. A 24 year old Cpl. was eliminated after 48 chamber hours because of "marked susceptibility to the bends." The one type 64 examination with laboratory studies was entirely negative. No further details were given as to bends frequency, severity or systemic reactions.

d. An 18 year old Pvt. was eliminated on the basis of myocardial insufficiency shortly after duties as pressure chamber technician were begun (total hours not recorded). There was a history of streptococcal throat infection in childhood complicated by cardiac involvement. An electrocardiogram showed low voltage T_1, inverted T_2 and T_3, and diphasic T_4 interpreted as evidence of myocardial insufficiency. His type 64 examination was otherwise within the range of normal. One and one half months later he again was examined with normal findings except for the presence of a non-transmitted mitral systolic murmur, not previously noted. A comparison of the two electrocardiograms revealed no appreciable change in leads 1, 2, and 3; the fourth lead lost its diphasic contour to resume the upright position. These changes were interpreted as "pathological evidence of the examinee's susceptibility to altitude" and he was relieved of altitude chamber duties on this basis. It must be admitted that such a conclusion is open to question.

4. Seven cases were grounded after a variable period of exposure (range of chamber hours, 31 to 227, average 100) by reason of the occurrence of "operational fatigue." A study by system of the interval 64 examinations on this group revealed the following data:

The examination of the eyes was not remarkable: slight decrease in visual acuity in two cases on the initial examination remained unaltered. Ears, nose, and throat were all negative. No abnormalities of the cardiovascular system were noted with the exception of one case where the blood pressure rose from 110/68 on initial examination to 174/124 millimeters of Hg after 149 chamber hours, only 4 hours of which occurred in the last 4 months. No comment was made as to verification of this or further observation of the crew member.

All laboratory studies including complete blood counts were within the range of normal. In one instance a "slight increase in hilar shadows" by roentgenogram of the chest after 185 hours in the pressure chamber was reported as normal after 227 hours. Antral changes suggesting polypoid mucosal thickening appeared in one man after 65 chamber hours, and was still present after 94 hours when he was eliminated by operational fatigue. Electrocardiographic changes appeared in one case where an inverted T_4 present on the original examination eventually corrected to the upright position (36 chamber hours). All cases in this group were qualified for altitude chamber duties by the type 64 examination but were eliminated at the request of the Chief of Altitude Training.

CONCLUSION

The examination of the medical records of a small group of altitude chamber technicians who were relieved of altitude chamber duties revealed a variety of medical factors involved. The majority of these factors were apparently unrelated to exposure to simulated altitudes as observed in six cases either with no actual chamber flights or with a very brief period of exposure (two cases prior to elimination).

Four men were eliminated for medical reasons after variable periods of exposure to simulated altitudes, i.e., "bends susceptibility," "psychologically unfit" and "electrocardiographic changes incident to exposure to high altitudes." In all instances the type 64 examinations were within range of normal with the exception of failure to pass the A.O.C. color vision plates in one case, and an electrocardiographic change in another.

The remaining group of seven cases consisted of men who after somewhat longer periods of exposure (range of 31 to 227, average 100 chamber hours) were eliminated by reason of "operational fatigue." This rather nonspecific category, although largest numerically revealed only three changes of note in the type 64 examinations, a rise in blood pressure after 149 hours, a "slight increase in hilar shadows" by roentgenogram after 185 hours, and evidence of polypoid mucosal thickening by roentgenogram after 65 hours of exposure to simulated altitude.

It seems scarcely necessary to emphasize the fact that the type 64 examination frequently fails to reveal minute changes, especially those of emotional or "psychic" nature. This was borne out by the fact that 11 of the 17 were eliminated not by the results of the serial type 64 examinations but by request of the Chief of Altitude Training. In each of these 11 cases the technician was qualified as psychologically and medically fit to perform chamber duties.

SUMMARY

The interval type 64 examinations on a group of 17 altitude chamber technicians who had been relieved of duties in the altitude training program for medical reasons were reviewed revealing that 6 were disqualified either without exposure to simulated altitudes or by reasons apparently unrelated to chamber flights. The remaining 11 men were eliminated by causes that appeared to be related to repeated exposure to simulated altitudes. Study of their records failed to disclose any common factor in the change of medical status. All but six were disqualified by psychological deficiency (2), bends susceptibility (2), or operational fatigue (7), with satisfactory completion of type 64 examination but elimination at the request of the Chief of Altitude Training. The group of six were disqualified by medical deficiencies apparently unrelated to exposure to simulated altitudes and with no common factor in evidence.

* * *

EFFECTS OF VARIOUS FACTORS ON THE FREQUENCY OF DESCENTS IN ALTITUDE CHAMBER FLIGHTS

SUMMARY OF REPORTS FROM ELLINGTON FIELD, HARLINGEN ARMY AIR FIELD, AND SAN ANTONIO AVIATION CADET CENTER

CAPTAIN O. M. RAY, A. C.
Altitude Training Unit
San Antonio Aviation Cadet Center

Effect of Time of Day

SYMPTOM	STATION	A. M.	P. M.	NIGHT
No Descent	27th Ellington	753 - 61.7%	808 - 70.4%	108 - 71.5%
	28th Harlingen	1282 - 65.6%	1555 - 72.3%	0 - 0
	29th S.A.A.C.C.	1458 - 76.3%	1323 - 78.9%	0 - 0
	Average*	67.9%	73.9%	71.5%
Descent Due to Aeroembolism	27th Ellington	373 - 30.5%	261 - 22.8%	34 - 22.4%
	28th Harlingen	524 - 26.8%	448 - 20.8%	0 - 0
	29th S.A.A.C.C.	363 - 19.0%	232 - 13.8%	0 - 0
	Average*	25.4%	19.1%	22.4%
Descent Due to Other Symptoms	27th Ellington	95 - 7.8%	78 - 6.8%	10 - 6.1%
	28th Harlingen	150 - 7.7%	149 - 6.9%	0 - 0
	29th S.A.A.C.C.	69 - 3.6%	98 - 5.8%	0 - 0
	Average*	6.4%	6.5%	6.1%
Eliminated in 5000 Foot Run	27th Ellington	144 - 10.5%	101 - 8.1%	16 - 9.47%
	28th Harlingen	273 - 12.2%	324 - 13.2%	0 - 0
	29th S.A.A.C.C.	20 - 2.7%	22 - 4.0%	0 - 0
	Average*	8.5%	8.4%	9.47%

These results are based on the four-hour classification flight described in the directive governing the altitude training program dated 15 November 1942. Three hours were spent at 38,000 feet.

Number of subjects tested (man flights) in any given time of day equals 100%. Those eliminated in 5000 foot run are not counted as tested but are computed on the same basis so the total per cents from any one station in each column exceed 100% by the amount in the last group.

*Averages are per cents and not mathematical averages.

In each instance, there are fewer descents in the afternoon than in the morning. However, the descents due to aeroembolism are appreciably greater in the morning. Insufficient data is available on night runs.

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Effect of Barometric Pressure

Station	Pressure Range MM Hg	No Descent	Descent Due to Aeroembolism	Descent Due to other Symptoms	Eliminated in 5000 Foot Run	Total Subjects Run
27th Elling.	770-777	323-58%	150-27.9%	33- 5.9%	51- 9.2%	557-20.2%
28th Harling.	781-768	336-58.6%	185-32.1%	52- 9.1%	89-13.4%	573-25.3%
29th SAACC	759-751	245-70.2%	69-19.7%	35-10%	0-0	349- 9.9%
Average*	768 MM Hg	62.3%	26.6%	8.3%	7.5%	18.5%
27th Elling.	762-770	730-59.6%	276-22.5%	88- 7.2%	131-10.7%	1225-44.5%
28th Harling.	767-761	669-69.8%	230-24.0%	59- 6.2%	161-14.4%	958-42.5%
29th SAACC	751-741	1610-80.1%	321-15.8%	77- 3.8%	29- 3.8%	2008-56.9%
Average*	759 MM Hg	69.8%	20.8%	5.7%	9.6%	47.9%
27th Elling.	737-762	654-67.3%	229-23.6%	54- 5.6%	35- 3.6%	972-35.3%
28th Harling.	760-752	489-66.7%	176-24.0%	68- 9.3%	103-12.3%	733-32.2%
29th SAACC	741-734	926-78%	188-16%	59- 5%	12- 2.2%	1173-33.2%
Average*	748 MM Hg	70.7%	21.5%	6.6%	6.0%	33.8%

The barometric pressure has been divided into three regions, high, medium and low starting at the top of the above table. Values are given for each pressure range for each station. Per cents are computed on the basis of man flights (men tested) for each station at each pressure range as 100%.

*These averages are per cent and <u>not</u> mathematical averages and are relatively significant.

It might be expected that there would be more symptoms and descents when the barometric pressure is high because the pressure difference to altitude is greater. The above table indicates that this is true. There were slightly fewer descents at medium and low pressure than at high pressure and there were more descents due to aeroembolism at a high barometric pressure. Probably the pressure range shown above (20 MM Hg from Average high to Average low) is not sufficient to cause a significant difference in symptoms. However, 20 MM Hg is equivalent to the altitude from 30,000 to 32,000 feet.

Effect of the Day of the Week

Day of Week	STATION	No.M %	No.T %	No.W %	No.Th %	No.F %	No.S %	No.S %
No Descent	27,Elling	299-68.2	291-66.1	263-64.7	321-72.9	284-68.5	229-62.2	0-0
	28,Harling	436-69.5	479-70.8	500-67.0	401-68.7	292-70.0	410-70.1	337-65.8
	29,SAACC	385-79.7	485-80.8	533-78.8	421-77.8	503-79.7	438-73.5	0-0
	Average*	71.8	72.6	70.2	73.1	72.7	68.6	65.8
Descent Due to Aeroembolism	27,Elling	109-24.8	114-25.9	107-26.3	94-21.4	103-24.8	111-30.2	0-0
	28,Harling	147-23.5	151-22.4	188-25.2	137-23.5	109-26.2	125-21.4	135-26.4
	29,SAACC	75-15.5	95-15.8	118-17.4	93-17.2	95-15	119-19.9	0-0
	Average*	21.3	21.4	23.0	20.7	22.0	23.8	26.4
Descent Due to other Symptoms	27,Elling	30- 6.8	35- 8.0	37- 9.1	25- 5.7	28- 6.7	28- 7.6	0-0
	28,Harling	44- 7.0	46- 6.8	59- 7.8	46- 7.8	16- 3.8	50- 8.5	40- 7.8
	29,SAACC	23- 4.7	25- 3.7	25- 3.7	27- 4.9	33- 5.2	39- 6.5	0-0
	Average*	6.1	6.2	6.9	6.1	5.2	7.5	7.8
Eliminated in 5000 Foot Run	27,Elling	39- 8.2	59-11.8	46-10.2	54-10.9	26- 5.8	36- 8.9	0-0
	28,Harling	91-12.7	90-11.8	114-13.2	92-13.6	53-11.6	77-11.6	75-12.8
	29,SAACC	12- 5.4	10- 3.2	10- 3.2	4- 2.5	11- 5.0	5- 2.8	0-0
	Average*	8.8	8.9	8.9	9.0	7.5	7.8	12.8

The number of subjects and the percents they constitute are given for each station for each day of the week. The percents have been computed on the basis of the number of man flights (men classified) for each day as 100%. Those subjects eliminated in the 5,000 foot run are not counted as classified (man flights) but are computed on the same basis; therefore, the total percents for any station for any day exceed 100% by the number eliminated in the 5,000 foot run.

*These are averages of percents and not mathematical averages. They are relatively significant and make it possible to survey the results quickly.

It may be noted that there is no significant difference in descents or survival correlated with the day of the week. SAACC serves as a control inasmuch as it has open post for many subjects during the week. The other stations have open post on week-ends only.

The general survival seems to be significantly greater at SAACC than the other stations. Those not descending are: SAACC - 78.4%; Ellington - 67.1%; Harlingen - 68.8%; average for the week. Descents due to aeroembolism are : SAACC - 16.8%; Ellington - 25.6%; Harlingen - 24.1%

Effect of Time at Altitude

Symptom	Station	No. 1st. Hr.	%	No. 2nd. Hr.	%	No. 3rd. Hr.	%
BENDS	27th Ellington	261	47.7	230	42.0	56	10.2
	28th Harlingen	550	63.1	246	28.2	75	8.6
	29th S.A.A.C.C.	264	48.3	223	40.8	59	10.8
	Average*		53.0		37.0		9.9
CHOKES	27th Ellington	30	27.8	60	55.6	18	16.7
	28th Harlingen	54	43.9	56	45.5	13	10.5
	29th S.A.A.C.C.	6	12.2	34	69.4	9	18.4
	Average*		28.0		56.8		15.2
GASTRO-INTESTINAL	27th Ellington	59	72.8	15	18.5	7	8.6
	28th Harlingen	181	83.0	27	12.3	10	4.6
	29th S.A.A.C.C.	110	90.9	7	5.8	4	3.3
	Average*		82.2		12.2		5.5
OTHERS	27th Ellington	65	67.7	25	26.0	6	6.3
	28th Harlingen	47	72.3	14	21.5	4	6.2
	29th S.A.A.C.C.	35	79.6	7	16.0	2	4.6
	Average*		73.2		21.2		5.7

Per cents are computed with the number of each symptom for three hours equal to 100%.

*Averages are average per cents, not mathematical averages, and make it possible to survey results quickly.

Approximate per cents appearing in the first hour are: Bends - 53%, Chokes - 28%, Gastro-intestinal - 82%, and Others - 73%. 37% of bends, 57% of chokes, 12% of gastro-intestinal and 21% of miscellaneous symptoms occur in the second hour.

EFFECTS OF ANOXIA ON PARETIC MUSCLES

COMMANDER B. J. WOLPAW, M. C., U.S.N.R.
U. S. Naval Air Training Center, Pensacola

A routine low pressure chamber indoctrination run at 18,000 feet for ten minutes was being carried out. In the chamber were a group of cadets and three medical officers. After the 18,000 foot level had been maintained for several minutes, one of the Doctors noted that the eyes of one cadet were both so markedly converged that only the white portions of the globes were visible. He thought that the cadet was in a serious condition and so signalled to the outside operator. The chamber was "crash dived" and upon reaching sea level the cadet stood up and walked out in excellent condition with both eyes almost straight. However, two of the Doctors had severe epistaxis and one a perforated eardrum!

Further examination revealed the cadet to have a bilateral external rectus paresis. The chamber run was repeated on this man and the same ocular features recurred. An enlisted man with a paresis of the left internal rectus was later run in the chamber and this time the left eye turned out. It appears as though with anoxia there is sufficient relaxation of a paretic muscle so that its antagonist goes unchecked.

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/This interesting account of an unusual experience during a chamber flight has been made available through the kindness of Commander Wolpaw at the request of the Editor of the Bulletin./

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